

Development of a Web Mapping Tool and Distribution Maps for Ontario Fishes with Emphasis on Species at Risk

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**CANADIAN TECHNICAL REPORT
OF FISHERIES AND AQUATIC SCIENCES**

**DEVELOPMENT OF A WEB MAPPING TOOL AND DISTRIBUTION MAPS
FOR ONTARIO FISHES WITH EMPHASIS ON SPECIES AT RISK**

By

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ABSTRACT

Doolittle, A., N. E. Mandrak, P. Brunette, D. Ming, C. Bakelaar. 2007. Development of a Web Mapping Tool and Distribution Maps for Ontario Fishes With Emphasis on Species at Risk. Can. Tech. Rep. Fish. Aquat. Sci. 2699: x + 45 p.

The primary objective of the Department of Fisheries and Oceans (DFO) is an overall net gain in the productive capacity of fisheries resources in Canada. This objective strives to protect fish species and their supporting habitat. With the introduction and proclamation of the Species at Risk Act in 2003 (SARA), this objective includes species at risk (SAR) and their critical habitat. In an effort to support this objective, DFO Science and Fish Habitat Management (FHM) Ontario Great Lakes Area (OGLA) are working together to provide fisheries biologists and managers with tools that facilitate the decision-making process related to fishes, including species at risk and their habitat. There is a need for ready access to fish distribution and habitat data at regional and local scales. Based on an extensive fish distribution database, a web mapping tool was developed. This tool facilitates the display of fish distributions by species at regional and local scales by watershed, stream segment or lake. It also provides users with information on SAR, including maps, reports, images, and links to other pertinent documentation. SAR distribution data is also the foundation for producing distribution maps used by scientists, biologists, and partners in the decision-making process. A collection of SAR distribution maps have been provided to DFO partners, including Conservation Authorities in Ontario. These maps and are being used to screen projects that might affect SAR and their associated habitat.

RÉSUMÉ

Doolittle, A., N. E. Mandrak, P. Brunette, D. Ming, C. Bakelaar. 2007. Development of a Web Mapping Tool and Distribution Maps for Ontario Fishes With Emphasis on Species at Risk. Can. Tech. Rep. Fish. Aquat. Sci. 2699: x + 45 p.

Le principal objectif du ministère des Pêches et des Océans (MPO) est de réaliser un gain net global de la capacité de production des ressources halieutiques au Canada. Cet objectif, qui vise à protéger les espèces et leur habitat, inclut les espèces en péril et leur habitat critique depuis la promulgation de la *Loi sur les espèces en péril* (LEP) en 2003. C'est donc dans cette perspective que les Sciences et la Division de la gestion de l'habitat du poisson (GHP) du MPO et Grands Lacs - secteur de l'Ontario (GLSO) unissent leurs efforts pour fournir aux biologistes et aux gestionnaires des pêches des outils qui leur permettent de faciliter le processus de prise de décisions en ce qui concerne les ressources halieutiques, dont les espèces en péril et leur habitat. Comme il est nécessaire de simplifier l'accès aux données sur la répartition des espèces et leur habitat à des échelles régionale et locale, un outil de cartographie fondé sur le Web a été conçu à partir d'une base de données exhaustive sur la répartition des espèces. Il permet d'afficher la répartition des poissons par espèce à des échelles régionale et locale et par bassin versant, segment de cours d'eau ou lac. Il présente à l'utilisateur des renseignements sur les espèces en péril, y compris des cartes, des rapports, des images et des liens à d'autres documents pertinents. Les données sur la répartition des espèces en péril servent également à la production des cartes de répartition utilisées par les scientifiques, les biologistes et les partenaires participant au processus de prise de décisions. Une série de cartes de répartition des espèces en péril a été remise aux partenaires du MPO, dont les Offices de protection de la nature de l'Ontario. On utilise aussi actuellement ces cartes pour repérer les projets susceptibles d'avoir une incidence sur les espèces en péril et leur habitat.

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1.0 INTRODUCTION

To protect SAR and their habitat, it is necessary to have an understanding of their geographic distribution, abundance and life history. A joint Science/FHM project is being developed to map and model fish and mussel SAR distributions. Scientific modeling will identify the distribution, critical habitat and potential threats to SAR using a GIS (Geographic Information System). When OGLA and its partners (Parks Canada Agency, Ontario Ministry of Natural Resources (OMNR), and Conservation Authorities) review proposed development projects for potential impacts to fishes and mussels and their habitat under the Fisheries Act, the GIS will assist in expediting the review process. It will provide geo-referenced and up-to-date information on fishes and mussels, including SAR and their recovery plans, so that informed decisions can be made to minimize impacts on SAR, and support DFO's goals of conservation, restoration and development of habitat. It will also provide a foundation for creating distribution maps, and supporting documentation for reports, presentations and recovery plans.

2.0 PURPOSE AND OBJECTIVES

The purpose of this report is to document the sources of data, tools and methods used in developing a geo-referenced distribution database for Ontario fishes and mussels, with emphasis on species at risk. This report also examines several key tools and products that utilize this information, including the development of a web mapping tool for Ontario fishes, as well as species distribution maps. The objective is to provide

biologists and managers with an accurate representation of fish and mussel distributions and to provide a database for use in mapping the distribution of SAR, develop internet web mapping tools, and provide a foundation for modeling and predicting SAR distributions. These accurate representations are important in developing and providing tools and maps to DFO employees, partners and clients.

3.0 METHODS

There are three key components that have supported and promoted the development of SAR applications in DFO:

1. Development of a geo-referenced Ontario fish distribution database
2. Ontario Aquatic Map Explorer web mapping tool
3. Species at Risk distribution maps

The first component refers to a comprehensive, geographically accurate fish distribution database, which was used as the foundation for both web mapping, and fish distribution modeling of both SAR and non-SAR species. The second component refers to a web mapping application, and associated tools used to represent, identify and report on fish, mussels, SAR distributions and related information for Ontario. The third component refers to documentation relating to SAR in Ontario, including distribution maps, reports, manuscripts and recovery plans.

3.1 DEVELOPMENT OF A GEOREFERENCED ONTARIO FISHES DISTRIBUTION DATABASE

3.1.1 Fish and Habitat Data

There are many complexities in developing a comprehensive fishes database for the approximately 250 000 lakes in Ontario, covering almost one-sixth of the province with an area of approximately 177 390 km², and countless millions of kilometres of streams (Education Canada, 2003). Without comprehensive knowledge of historical fish distribution patterns, one cannot clearly understand the evolutionary history of a species. This knowledge can facilitate the protection of critical habitat and management of aquatic ecosystems for the future (Mandrak & Crossman, 1992).

A national freshwater fishes distribution database, developed by N. Mandrak (DFO Science), contains close to 400 000 individual records for all of Canada (N.E. Mandrak, *unpublished data*). This database includes data from various agencies and programs including DFO, Canadian Museum of Nature, Ontario Ministry of Natural Resources (OMNR) lake and stream inventories, and the Royal Ontario Museum (ROM). Currently, the database has over 250 000 geo-referenced records for Ontario (Figure 1). Of those, there are over 9 000 SAR records, including fishes and mussels (Figure 2).

The distribution of the records covers most of Ontario, except for the poorly sampled James Bay lowlands. Each record represents the collection of a single species at a specific location on a specific date. Each record includes fields such as scientific name, waterbody name, locality description, location coordinates, date of capture, source of the



Figure 1. Fishes and mussel distributions in Ontario



Figure 2. Fish and mussel species at risk distributions in Ontario

data (catalogue number), as well as other species-specific information (taxonomic level and native status). Each record contains 18 variables (Table 1).

Table 1. Fish distribution variables

| Variable | Description |
|------------------|---|
| NFWDD_ID | Primary key in the table |
| Scientific_Name | According to AFS Names List (Robins et al., 1991) |
| Common_Name | Species common name |
| Province | Province where sample point is located |
| Waterbody | Waterbody name or description |
| Lentic_Lotic | Lentic (standing water) or lotic (flowing water) |
| Latitude | Decimal degrees |
| Longitude | Decimal degrees |
| Datum | NAD83 |
| Georef_Source | Method or source used to derive location coordinates |
| TWS | Tertiary watershed code |
| Date_of_Capture | Date of capture |
| Year | Year captured |
| Month | Month captured |
| Catalogue_Number | Catalogue number assigned to sample by Royal Ontario Museum |
| Occurrence | Freshwater, marine, both. According to Robins et al., 1991 |
| Taxonomic_Level | Species, genus, family, questionable identification, hybrid |
| Native_Status | Native/not native to Canada |

The database includes both historic (pre-2000) and current records. In an effort to increase knowledge of fish distributions, particularly for fish and mussel SAR, DFO field crews have been actively collecting new data from rivers and lakes across southern Ontario since 2002. As new sites are sampled, historic samples are also revisited in an effort to compare and contrast records obtained in previous years. Since the proclamation of SARA, focus has shifted to sampling SAR and their associated habitat. Field

biologists document and collect SAR specimens and DNA, and also document relevant habitat data for future identification of SAR critical habitat (Figure 3). Using state-of-the-art GPS technology, data are digitally recorded and uploaded to a relational database.



Figure 3. DFO field crews sampling for fishes

These data, combined with historical fish and mussel sampling records, provide a foundation for a comprehensive GIS-based distribution database.

3.1.2 Georeferencing Fish and Mussel Distribution Data

A fully georeferenced fish and mussel distribution database is essential for recognizing distribution patterns and for accurately summarizing species by watershed. By locating sample points accurately on lakes and streams, scientists will be able to:

- (1) identify known distributions,
- (2) identify key characteristics for fish and mussel habitat, and
- (3) develop predictive models for fish and mussel SAR.

A small proportion of the fish records in the database date back to the early 1900's, however, the most significant sampling effort was between the years 1970 and 1979 - this can be attributed to OMNR's lake and stream inventory program (Figure 4).

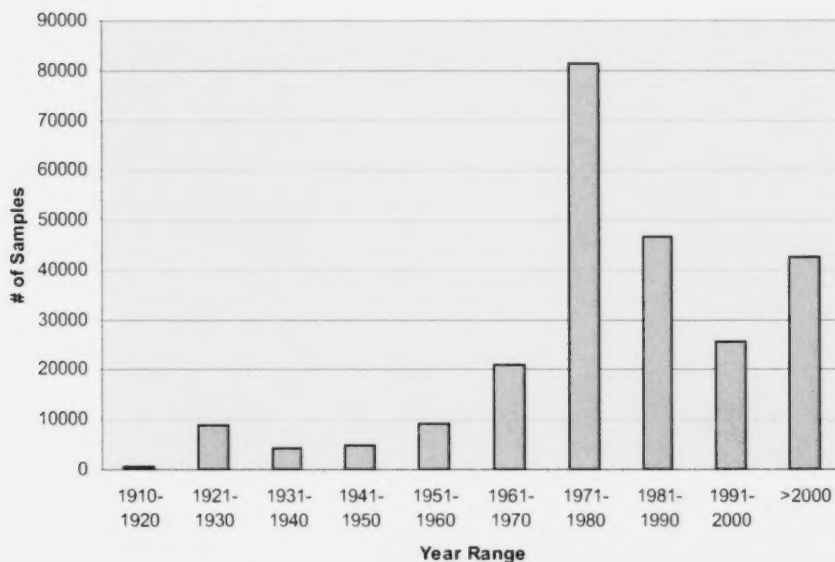


Figure 4. Histogram of fish sampling records between 1910 and present

As a result, the location accuracy of the data points might be compromised due to limitations in technology for that time period. Although the species' identifications have been verified to be correct, many of the location coordinates (latitude/longitude) have not been verified. Based on the descriptive data and the given location, some sample points were either found on the correct waterbody, or in close proximity of the correct location. Conversely, some sample points were found a considerable distance away from the correct location, sometimes hundreds of kilometres away. This may be the result of old technology, poor georeferencing, transcription error, latitude or longitude shifts or incorrect location references. In some circumstances, a few lakes in Ontario share a common name and are within close proximity of each other (within 100 km), therefore, accurately locating points using tools such as the "Canadian Geographic Names Database" (Natural Resources Canada, 2007) becomes a difficult task, and is often left to the discretion of a user inputting the data.

3.1.3 Primary Geographic Data Sources

To accurately relocate fish sample points, a variety of data sources were used in the georeferencing process. Several base maps were used, including OMNR Natural Resource Values Information System (NRVIS) layers, such as waterline, waterbody, road segment, and geographic names. Data from Natural Resources Canada (NRCAN) included National Topographic Data Base (NTDB) themes, including road and rail networks at 1:50 000 scale, Topographic Names label points (Toponyms) at both a 1:50

000 and 1:250 000 scale, and the 1:50 000 and 1:250 000 waterbody layers. The Toponyms themes at both scales were used as the primary feature name look-up table for the geo-referencing exercise as it provides an accurate reference to point locations for named waterbody features for both lakes and rivers.

3.1.4 Primary Software

Various software packages were used in this exercise, which included ESRI'sTM ArcGIS® 9.1 and Microsoft® AccessTM XP. ArcMap® was used as the primary georeferencing and attribute-editing software, and AccessTM was use to store the georeferenced data.

3.1.5 Georeferencing Methods

The original records in the database were separated into two tables based on a field identifying whether or not the record was lentic in nature (relating to non-flowing water) or lotic (relating to flowing water). Lentic records are much easier to verify because they simply need to be on the correct waterbody; thus, the Toponyms layer could be used as a reference to identify a specific location. One of the shortfalls in mapping on a provincial level is that stream layers used in DFO lack specific attributes, namely, waterbody names. Verifying lotic records was much more intensive. The Toponyms layer does provide river and stream names, which are often spread over a distance and not necessarily adjacent to the fish sampling points. For instance, one river label in the

Toponyms layer may fall near the mouth of the river, while another label for the same river system may fall elsewhere in the system, possibly several kilometres away. There appeared to be a lack in uniformity related to how the label points are located. With this in mind the lotic sample points cannot be simply “snapped” to the nearest Toponyms point because it may not reflect the correct location of the sample point. Two different approaches (lentic, lotic) were used to verify the correct location for the fish sampling points. It is important to note that only the fish distribution records were processed using these approaches. These processes could also be used for mussel distribution, although, data were not available when this study was completed.

3.1.6 Lentic Sample Points

The records associated with lentic features (e.g. lakes, ponds) represent records caught on both inland waterbodies and in the Great Lakes proper. For this exercise, Great Lakes records were removed in the current study.

There are over 250 000 lakes in Ontario, many of which have unique waterbody names. In Southern Ontario, a 1:10 000 scale waterbody layer was used to locate points. In Northern Ontario, 1:20 000 waterbodies were used, as well as 1:250 000 for the extreme northern areas.

An automated process, programmatic solution, was initially considered to identify the closest waterbody with the same name, and getting proper location coordinates; however, there are hundreds of waterbody names duplicated across the province. An automated process may be a viable option in a local or small-scale project, but it is much more

challenging when applied to the provincial scale because waterbodies of relatively close proximity may share the same name (Figure 5).



Figure 5. Lakes in the Parry Sound area that share a common name

A second automated approach which snapped the fish distribution points to the nearest waterbody was considered. This method also proved to be unreliable as many points had incorrect position information. Other issues included:

- Descriptive fields in the fish table were insufficient or too complex for automated snapping process (i.e. not standardized)
- Names of lakes or waterbodies were incomplete in lookup tables (Toponyms or waterbody GIS layers)
- Some lake names were based on local names in the fish table (names given by local residents)
- Scale of the data differed in Northern Ontario – not as many features represented in base layers

To capture as many correct lake records as possible, it was necessary to identify a layer that covered the province in a uniform manner and that could be used to distinguish waterbodies and locations relative to fish sample points. As a result, the National Topographic Sheet (NTS) reference layers (1:50 000 & 1:250 000) were used as a “spatial reference” for waterbodies (Figure 6).

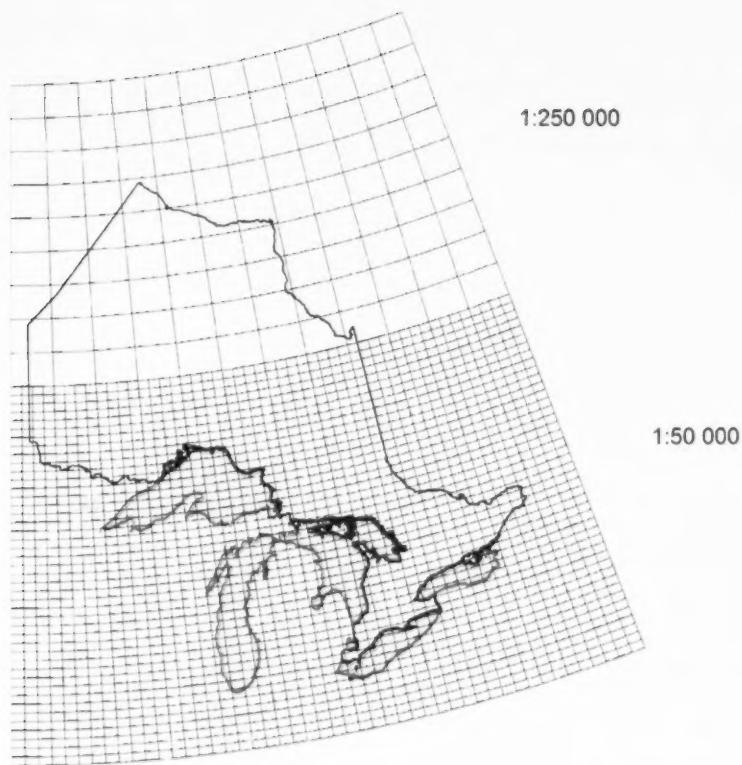


Figure 6. Combined 1:250 000 and 1:50 000 NTS grid sheet reference for Ontario

These layers provided a standardized and uniform approach when assigning a limited number of waterbody names to a specific grid, minimizing the potential for duplication within each grid cell. After spatially joining the NTS grid codes to the Toponyms layer, waterbodies could be identified by both a waterbody name and NTS sheet number. This spatial join was also performed on the lentic records in the fish layer, where NTS sheet numbers were joined to the fish sample records. Similar to the

waterbody names in the Toponyms layer, each record in the fish sample table contained fields for waterbody name and NTS sheet number (Figure 7).



Figure 7. Querying new latitude/longitude coordinates

After adding latitude and longitude coordinate fields to the toponyms layer and to the fish sample table, both were imported into Microsoft® Access™. Using a simple query, both tables were joined on matching fields: waterbody name and NTS sheet number.

Over 45,000 records matched using these unique criteria. Since the toponyms layer has correct latitude and longitude coordinates, those fish records that matched were assigned the new coordinates. In only a few situations, NTS sheets had more than one waterbody with the same name. In this case, the points were snapped to the waterbody with the same name that was closest to the fish sample point using calculations on the coordinates. For the remaining waterbody records, identifying correct or assumed correct locations was done manually. In the fish sample table, a general waterbody field provided either a waterbody name, or a general description of the location of the sample (e.g. “in the

marsh, by the road"). Some waterbody descriptions had only local names associated to the point (names given to the waterbody by the local residents), others had incorrect spelling. With this in mind, and with the available reference layers, points were manually moved to a waterbody that was assumed correct, based on waterbodies found nearby, descriptions, access or size (Figure 8).



Figure 8. Example of locating lentic samples on correct waterbody

While this method may result in location inaccuracies in the data, especially in areas where waterbody names are not available (far north), it is still important to recognize that species compositions found in the area are similar, and will not affect the overall result of the project; therefore, these locations were considered accurate for the current study.

3.1.7 Lotic Sample Points

Lotic sample points were much more difficult to manage using an automated approach. Sample points cannot simply be “snapped” to the nearest toponyms label point as each label point is not necessarily adjacent to the sample point. Sample points could not be snapped to the nearest stream since the point may have been closer to a smaller, incorrect tributary (possible result of poor reception with a GPS). Other issues noted include:

- not all streams in Ontario are named
- not all streams were attributed in the GIS layer
- some stream names used local names
- some streams may no longer exist
- scale of the data differed i.e. Northern Ontario
- waterbody name field was vague, difficult to interpret
- waterbody name field in the fish table was based on a river system name rather than a tributary name

Connecting fish sample points to streams spanning several decades becomes a challenge when these issues arise. As a result, it was much more laborious in nature geo-referencing stream sample points, sorting through individual or groups of records in an effort to accurately locate the points on the correct stream segments. To capture some of the migratory fishes that use the rivers to spawn, sample points found within 5 km of river and stream mouths in the Great Lakes were included in this analysis. A GIS stream segment layer from the OMNR was used as the foundation for this exercise.

3.1.8 ALIS Stream Segments

The OMNR Aquatic Landscape Inventory System (ALIS) layer defines segments of streams based on a number of unique characteristics found only within those valley segments. Each valley segment is defined by a collection of landscape variables that have a controlling effect on the biochemical processes within the catchment. These variables are considered to be the basic template within which a stream ecosystem evolves (Stanfield & Kuyvenhoven, 2003). The primary variables include upstream drainage area, position, connectivity, surficial geology, slope, climate, barriers and land cover (Table 2). The following attribute descriptions were taken from the report by Stanfield and Kuyvenhoven (2003):

Table 2. ALIS attributes

| | |
|-------------------------------|---|
| Upstream Drainage Area | Area calculated from the bottom of each segment, as well as the area of lakes and wetlands within the drainage area |
| Position | Area calculated based on the difference in drainage area for the proximal valley segment and the immediate downstream segment – attempt to capture the contrast in stream size between adjoining segments |
| Connectivity | Identifies whether a segment is connected to any of the following features either in the upstream or downstream directions: inland lakes, Great Lakes, salt water and wetlands |
| Surficial Geology | Upstream drainage area of the 32 distinct classes of geology, and hydraulic conductivity assigned to each geology type |
| Slope | Calculated based on data from a Digital Elevation Model |
| Climate | Total annual precipitation and average summer temperature interpreted from the regional weather maps by Environment Canada |
| Barriers | Locations of known dams and barriers found within the OMNR – NRVIS database |
| Land Cover | Provincial Landsat land cover dataset is used to calculate areas for each of the 28 different land cover classes – converted to percentages of the upstream drainage area |

ALIS have been disseminated by the OMNR into two components – a spatial layer representing the geometry of streams found within the Great Lakes basin, and a database of the attributes listed above (Table 2). Each segment in the spatial layer was given a unique segment identification number (Segment_ID), which subsequently identified related attribute data found in the database tables. Each segment may incorporate multiple streams if the streams all share a unique combination of landscape variables that define the segment. Conversely, segments may split apart a stream if there is more than one unique combination of landscape variables found within the stream system.

In an effort to model the distribution of fish and mussel SAR in Ontario streams, DFO has adopted this “valley segment” approach. Fish or mussel sample points are merged with these stream segments to provide summaries based on these unique Segment IDs, which demonstrated the importance of accurate sampling points. Although it would be useful to incorporate the habitat data from ALIS, it is important to note that only the geometry of the segments have been utilized for this exercise.

With over 88 000 stream records, a tertiary watershed approach was used to manage and process the sample points. Samples were examined and processed in each watershed independently in an effort to scale down the project into manageable units. If sample point locations reflected the waterbody description field given in the table (and based on the sample location coordinates had no potential for snapping to the wrong segment in an automated process), they were left in their original position. For the other sample points that were in the general vicinity of the segment (but did have the potential to snap to the wrong segment in an automated process), were manually moved to the correct location. For some points, incorrect transcription of latitude/longitude

coordinates were an issue and could often be corrected visually. For others, the waterbody description field could not provide enough information to manually relocate the point to an assumed correct location, and subsequently these records were removed from the analysis (Figure 9).

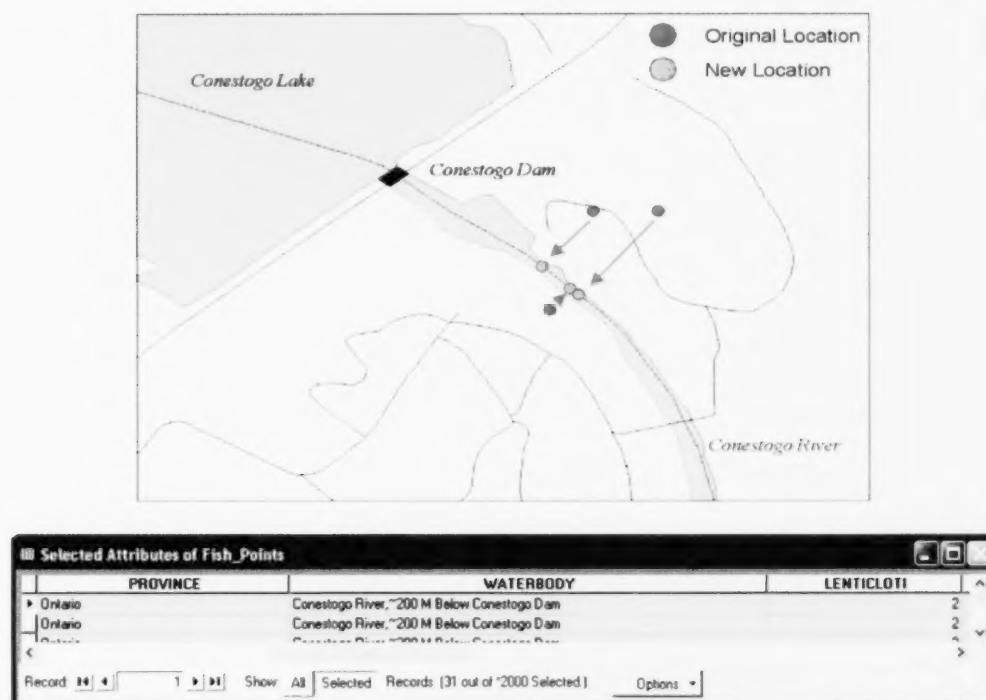


Figure 9. Example of stream records snapped to closest stream segment

While there are a variety of extensions and scripts available on the internet that automate the movement of geographic points to lines, this exercise references the ArcGIS® "Near" command. Specifically, points were snapped to the ALIS layer using a standard search radius of 10 m (Figure 10).

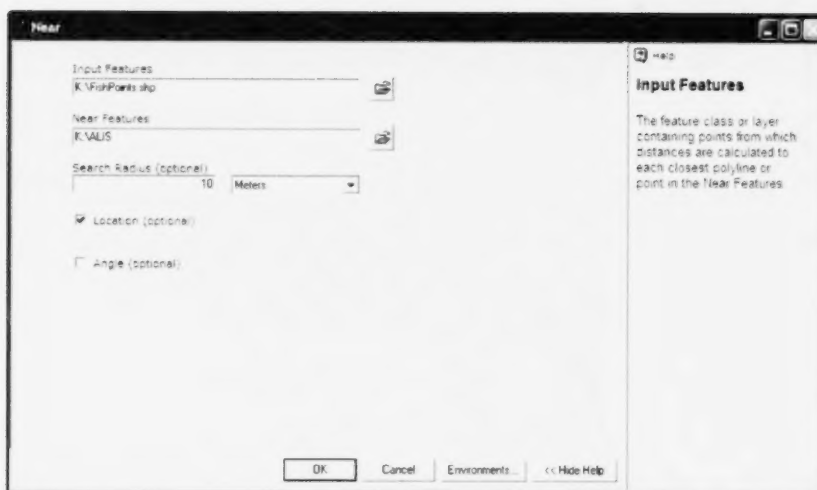


Figure 10. ArcGIS® “Near” command

Using a spatial join, points were given attributes of the nearest stream segment (or the stream segment on which the point falls). After calculating new XY coordinates, points were exported from ArcMap® and imported into an Access™ database.

The same process was applied for Northern Ontario, however, data at a scale of 1:250 000 was used to locate sample points.

The total number of lentic records, lotic records, and ALIS segments can be found in Table 3.

Table 3. ALIS summary

| | |
|---------------------------------------|---------|
| Total number of lentic records: | 111 075 |
| Total number of lotic records: | 108 080 |
| Total number of unique ALIS segments: | 139 942 |

3.1.9 Modeling Distributions Using Color-Coded Segments

Based on an individual species' status or schedule, stream segments with fish and mussel SAR distributions were color-coded red, orange or purple. Red segments represented known distributions of fishes and/or mussels designated as Extirpated, Endangered or Threatened on Schedule 1 of the federal Species at Risk Act (SARA). These species are afforded protection under SARA and project activities proposed in any red segments must not contravene the prohibition sections 32, 33 and 58 of SARA (DFO, 2006b). Orange segments represented the known distributions of fishes and/or mussels designated as Extirpated, Endangered and/or Threatened not currently on Schedule 1, but that are anticipated to be added to Schedule 1 in 2007-2008. Although the SARA prohibitions do not currently apply to species found in the orange segments, they could in the near future. Purple segments represented the distributions of fishes and/or mussels designated as Special Concern on Schedules 1 and 3 of SARA, and newly assessed as Special Concern but awaiting formal addition to Schedule 1. The prohibitions of SARA (Sections 32, 33 and 58) do not apply to species designated as Special Concern (DFO, 2006b). This information is summarized by stream segment ID and filtered to take the most cautionary approach for use in the Ontario Aquatic Map Explorer. For example, if a stream segment contains species found in a purple category, but also has species from the orange category, the segment would be classified as orange. An example of how the data was presented can be found in the "Local Approach" section of this report. As new data is collected and incorporated in the database, these attributes may or may not change based on the species collected, and based on changes in designations by COSEWIC.

As the roles of fisheries managers and biologists change to address concerns related to fish and mussel species at risk and critical habitat, so must the decision support tools. An intranet web mapping application has been developed by DFO Science and DFO-OGLA Program Services. Originally, this application was created to facilitate the decision-making process regarding referrals and permits for development, geographical references and locating projects. It has since evolved to incorporate new species at risk information and documentation (e.g. COSEWIC reports, images), query functionality, and map production (Figure 11).



3.2.1 Base Layers

A number of base layers were used in the SAR web mapping application, including data from the OMNR, NRCAN (NTDB data), and DFO (Table 4).

Table 4. Layers used in web mapping application

| Group | Layer Name |
|----------------------------|---|
| DFO Layers | DFO.Fish_Distribution |
| Place Names | NRVIS.Settlement NTDB.GeoNamePlace NTDB.Toponyms250K NTDB.Toponyms50K |
| District Boundaries | DFO.OGLA_Districts NRVIS.Cons_Auth_Levels NRVIS.OMNR_Region NRVIS.OMNR_District |
| Grid Reference | NRVIS.OBM_Index NRVIS.NTS_50K_Grid NRVIS.NTS_250K_Grid |
| Elevation/Relief | NRVIS.Contour NTDB.Hypsography250K |
| Parcel/Municipal | NRVIS.Concession NRVIS.LotCon NRVIS.Crown_Land NRVIS.Geographic_Townships NRVIS.MunicipalUpper NRVIS.MunicipalLower NRVIS.Land_Ownership |
| Parks/Reserves | NRVIS.Env_Sens_Area NRVIS.Municipal_Park NRVIS.NGO_Nature_Reserve NRVIS.Conservation_Reserve_regulated NRVIS.Crown_Game_Preserves NRVIS.National_Wildlife_Area NRVIS.ProvincialParkZone NRVIS.ProvincialParkRes NRVIS.National_Park |
| Water Related | NRVIS.Drainage_Point NRVIS.Water_Supply NRVIS.Drainage_Line NTDB.WaterRelated250K NTDB.WaterRelated50K |
| Watersheds | NRVIS.Watershed_Primary NRVIS.Watershed_Secondary NRVIS.Watershed_Tertiary NRVIS.Watershed_Quaternary |
| Base Layers | NRVIS.ProvincialBND600K NRVIS.GreatLakes600K NRVIS.ProvincialOutline10K |

| | |
|--|-------------------------|
| | NTDB.Transportation250K |
| | NRVIS.Airports10K |
| | NRVIS.Buildings10K |
| | NRVIS.Trailsegment10K |
| | NRVIS.TransportLine10K |
| | NTDB.Railroads250K |
| | NRVIS.Railroads10K |
| | NTDB.Roads250K |
| | NTDB.Roads50K |
| | NRVIS.Roads10K |
| | NRVIS.Ferry10K |
| | NTDB.Watercourse250K |
| | NRVIS.Waterflow10K |
| | NTDB.Wetlands250K |
| | NRVIS.Wetlands10K |
| | NTDB.Waterbody250K |
| | NRVIS.Waterbody10K |
| | NTDB.BuiltUpArea250K |
| | NTDB.BuiltUpArea50K |
| | NTDB.Vegetation250K |
| | NRVIS.Woodedarea10K |

Specific to Species at Risk, users have access to information based on the tertiary watershed layer (NRVIS.Watershed_Tertiary) and the ALIS stream segment layer (DFO.Fish_Distribution). Access to this SAR information can be examined at two scales; regional approach or local.

3.2.2 Regional Approach

A regional approach provides managers and biologists with a watershed-based inventory of species and pertinent information to aid in the decision-making process. Specifically, the regional approach provides distribution maps by species, and species lists, at the tertiary watershed level. Although the regional approach includes all species, additional information is provided for fish SAR. Specifically, users can:

- Query and report by tertiary watershed on all fish species, which highlights SAR records for that particular watershed (Figure 12)

- Query and report by tertiary watershed for fish SAR, with links to detailed SAR information (Figure 13)
- Display fish SAR fact sheets with relevant biological information (Figure 14)
- Display COSEWIC and other scientific reports (Figure 15)
- Display related recovery strategies (Figure 16)
- Display distribution maps for fishes by tertiary watershed (Figure 17)
- Display images of fish SAR (Figure 18)

RPT_ALL_FISH_WSH - Microsoft Internet Explorer

http://buria69.socesat.gov.RPT_ALL_FISH_WSH.aspx?this=200

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Freshwater Fish Distribution - Watershed Report

Tertiary Watershed Code: 2GG

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[COSEWIC Web Site](#)
[NRCC Web Site](#)
[SARA Registry](#)
[Species At Risk](#)
[NCR Habitat Web Site](#)

| Scientific Name | Common Name | COSEWIC | COSEWIC Listing Date | OMNR | GRANK |
|--------------------------|------------------------|---------|----------------------|------|-----------------|
| Alosa pseudoharengus | alewife | | | | G5 (1996-09-09) |
| Lepomis microlophus | American brook lamprey | | | | G4 (1996-09-09) |
| Anguilla rostrata | American eel | SC | 2007/8 | | G5 (1996-09-09) |
| Fundulus diaphanus | blanched killifish | | | | G5 (1996-09-20) |
| Ichthyosoma cyprinoides | bigmouth buffalo | SC | 2007 | NR/C | G5 (1996-09-19) |
| Ameiurus marmoratus | black hellgramite | | | | G5 (1996-09-19) |
| Pomoxis nigromaculatus | black mallee | | | | G5 (1996-09-23) |
| Moxostoma valenciennesi | black redbreast | THR | 2007 | THR | G5 (1996-09-19) |
| Notropis heterodon | blackchin shiner | | | | G5 (1996-09-16) |
| Rhinichthys cataractae | blacknose dace | | | | G5 (1996-09-17) |
| Notropis heterodon | blacknose shiner | | | | G5 (2000-02-16) |
| Percina maculata | blackside darter | | | | G5 (1996-09-24) |
| Fundulus notatus | blackstripe topminnow | SC | 2002 | | G5 (1996-09-20) |
| Lepomis macrochirus | bluegill | | | | G5 (1996-09-23) |
| Pimephales notatus | bluntnose minnow | | | | G5 (1996-09-17) |
| Amia calva | bowfin | | | | G5 (1996-09-09) |
| Hybognathus hankinsoni | brassy minnow | | | | G5 (1996-09-13) |
| Notropis muriei | branded madfish | | | NR/C | G5 (1996-09-19) |
| Labeocheilus bicoloratus | brook silverside | | | | G5 (1996-09-20) |
| Culaea inconstans | brook stickleback | | | | G5 (1996-09-20) |
| Salvelinus fontinalis | brook trout | | | | G5 (1996-09-12) |
| Ameiurus nebulosus | brown hellgramite | | | | G5 (1996-09-19) |
| Salmo trutta | brown trout | | | | G5 (1996-09-12) |
| Ichthyosoma sp. | buffalo | | | | G5 (1996-09-12) |
| Umbra limba | central mudminnow | | | | G5 (1996-09-13) |
| Campostoma anomalum | central stoneroller | | | NR/C | G5 (1996-09-13) |
| Ichthyosoma punctatus | channel catfish | | | | G5 (1996-09-19) |
| Percina copelandi | channel darter | THR | 2006 | THR | G4 (1996-09-24) |
| Oncorhynchus tshawytscha | Chinook salmon | | | | G5 (1996-09-08) |
| Nocomis biguttatus | chub | | | | |
| Hybognathus sp. | chub | | | | |
| Oncorhynchus kisutch | coho salmon | | | | G4 (1996-09-25) |
| Cyprinus carpio | common carp | | | | G5 (1996-09-13) |
| Luxilus cornutus | common shiner | | | | G5 (1996-09-18) |
| Pomoxis sp. | crappie | | | | |
| Semotilus atromaculatus | creek chub | | | | G5 (1996-09-17) |
| Percina sp. | darter | | | | |
| Ammocetes pelagicus | eastern sand darter | THR | 2002 | | G5 (1996-09-24) |
| Notropis atherinoides | emerald shiner | | | | G5 (1996-09-16) |
| Semotilus corporalis | fatfish | | | | G5 (1996-09-17) |

Figure 12. All species report

RPT_SAR_FISH_WSH - Microsoft Internet Explorer

File Edit View Favorites Tools Help

http://bur539.SpeciesAtRisk/RPT_SAR_FISH_WSH.aspx?tw=2GG

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Tertiary Watershed: 2GG
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[NHIC Web Site](#)
[SARA Registry](#)
[Species At Risk](#)
[HCR Habitat Web Site](#)

| | |
|--------------------------------------|---|
| Common Name American eel | Scientific Name <i>Anguilla rostrata</i> |
| | COSEWIC Status SC |
| | SARA Schedule 3 |
| | COSEWIC Listing Date 2007.8 |
| | COSEWIC Report Fact Sheet |
| | Tertiary Watershed Map |
| | Species Picture |
| Common Name bigmouth buffalo | Scientific Name <i>Ictalurus nebulosus</i> |
| | COSEWIC Status SC |
| | SARA Schedule 3 |
| | COSEWIC Listing Date 2007 |
| | COSEWIC Report Fact Sheet |
| | Tertiary Watershed Map http://bur539/SpeciesAtRisk/COSEWIC-Reports/BigmouthBuffalo.pdf |
| | Species Picture http://bur539/SpeciesAtRisk/SARA-Maps/BigmouthTWS.jpg http://bur539/SpeciesAtRisk/SARA-Pics/BigmouthBuffalo.JPG |
| Common Name black redbreast | Scientific Name <i>Morone chrysops</i> |
| | COSEWIC Status THR |
| | SARA Schedule 2 |
| | COSEWIC Listing Date 2007 |
| | COSEWIC Report Fact Sheet |
| | Tertiary Watershed Map http://bur539/SpeciesAtRisk/SARA-Maps/blackredbreastTWS.jpg |
| | Species Picture http://bur539/SpeciesAtRisk/SARA-Pics/BlackRedbreast.JPG |
| Common Name blackstripe topminnow | Scientific Name <i>Fundulus notatus</i> |
| | COSEWIC Status SC |
| | SARA Schedule 1 |
| | COSEWIC Listing Date 2003 |
| | COSEWIC Report Fact Sheet http://bur539/SpeciesAtRisk/FactSheets/BlackstripeTopminnow.pdf |

Done Local intranet

Figure 13. Species at risk watershed report

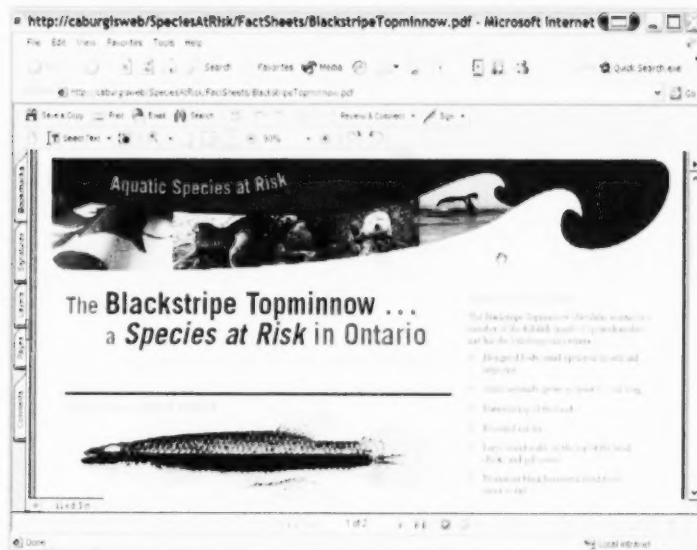


Figure 14. Species at risk fact sheet

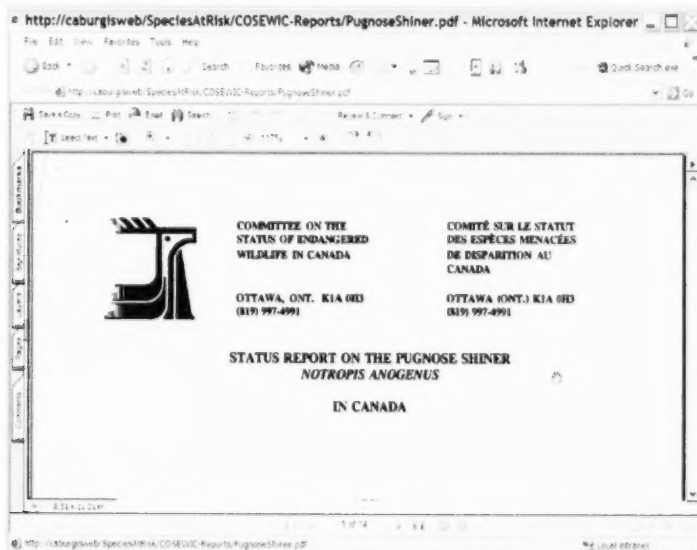


Figure 15. Species at risk COSEWIC report

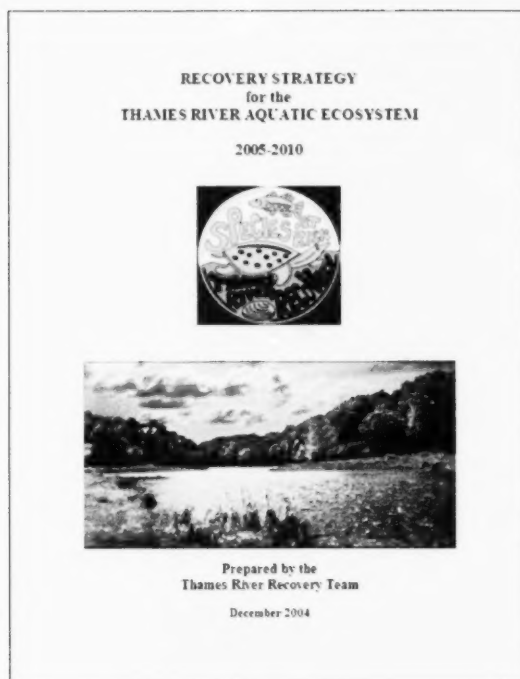


Figure 16. Species at risk recovery strategy



Figure 17. Species at risk watershed distribution maps

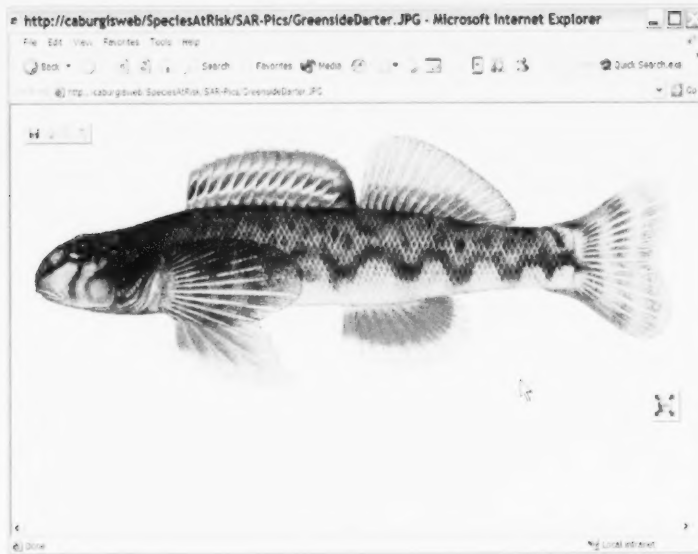


Figure 18. Species at risk images

3.2.3 Local Approach

The local approach provides distribution maps by species, and species lists, at the stream segment level based on the OMNR ALIS layer. It is being used by fisheries managers and biologists to review project proposals and assess whether projects are occurring in areas of known Species at Risk locations.

Like the regional approach, the local approach includes all fish species and provides additional information for fish SAR. Users can:

- Query and report by stream segment (Figures 19-21) or by species (Figure 22) (providing a more accurate picture of fish SAR distributions without revealing exact locations of sample sites)
- Display static distribution maps for Ontario (Figure 23)

- Display SAR distribution maps by OGLA districts (Figure 24)
- Link to other fish SAR information as in the regional approach

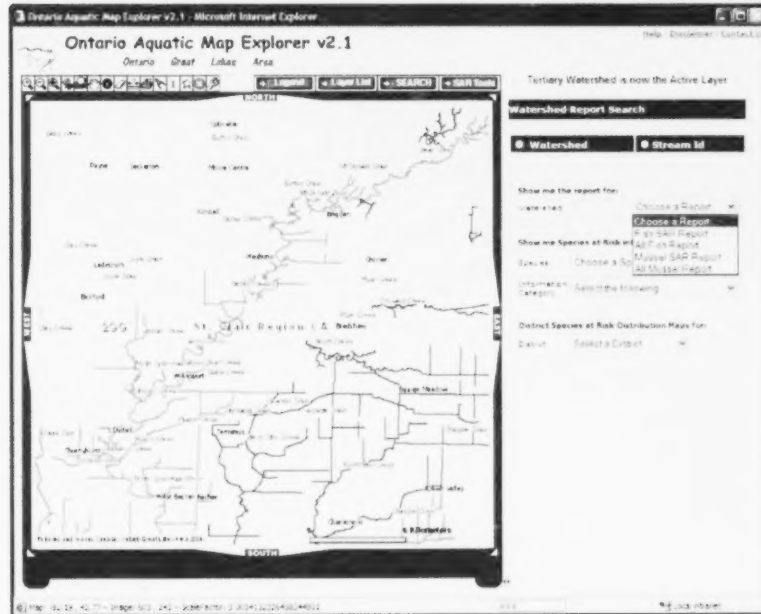


Figure 19. Stream query interface

RPT_SAR_FISH_SEG - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Search Favorites

Address http://burs50.speciesatRisk.RPT_SAR_FISH_SEG.aspx?Seg_id=55432

1 of 3 100% crystal

Environment and Heritage Canada

Freshwater Fish Species At Risk Distribution - Stream

Stream Segment ID: 55432

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[COSEWIC Web Site](#)
[NHIC Web Site](#)
[SARA Registry](#)
[Species At Risk](#)
[NCH Habitat Web Site](#)

| Common Name | Scientific Name | COSEWIC | SARA Schedule | COSEWIC Listing Date | Fact Sheet | COSEWIC Report | Tertiary Watershed Map | Species Picture |
|-----------------------|-------------------------------------|---------|---------------|----------------------|---|---|---|---|
| eastern sand darter | <i>Ammocrypta pellucida</i> | THR | 1 | 2003 | http://burs50.speciesatRisk/FactSheets/EasternSandDarter.pdf | http://burs50.speciesatRisk/COSEWIC/Reports/EasternSandDarter.pdf | http://burs50.speciesatRisk/SAR/Maps/eastandsdarterTWS.jpg | http://burs50.speciesatRisk/SAR/Photo/EasternSandDarter.JPG |
| grass pickerel | <i>Esox americanus vermiculatus</i> | SC | 1 | 2006 | COSEWIC Report | Tertiary Watershed Map | Species Picture | |
| greenside darter | <i>Etheostoma blennioides</i> | SC | 3 | 2007 | http://burs50.speciesatRisk/COSEWIC/Reports/GreensideDarter.pdf | http://burs50.speciesatRisk/SAR/Maps/greensidedarterTWS.jpg | http://burs50.speciesatRisk/SAR/Photo/GreensideDarter.JPG | |
| blackstripe topminnow | <i>Fundulus notatus</i> | SC | 1 | 2003 | http://burs50.speciesatRisk/FactSheets/BlackstripeTopminnow.pdf | | | |

Done Local intranet

Figure 20. Stream query results for fish SAR

RPT_ALL_FISH_SEG - Microsoft Internet Explorer

http://bunrui.SpeciesRisk.RPT_ALL_FISH_SEG.aspx?Seq_d=56432

powered by crystal

Home and Desktop Notes at 00:00:00
Canada

Freshwater Fish Distribution - Stream

Stream Segment ID: 56432

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Coastal Web Site
Atchafalaya Web Site
SARA Registry
Species At Risk
NCR Habitat Web Site

| Scientific | Common Name | COSEWIC | COSEWIC Listed Date | OMNR | GRANK |
|----------------------------------|-----------------------|---------|------------------------|------|-----------------|
| <i>Alosa pseudoharengus</i> | alewife | | | | Q5 - 1995-09-09 |
| <i>Rundulus diaconus</i> | bandied killifish | | | | Q5 - 1995-09-20 |
| <i>Notropis cyathostomus</i> | supporth buffalo | SC | 2007 | 12AC | Q5 - 1995-09-19 |
| <i>Ameiurus melas</i> | black bullhead | | | | Q5 - 1995-09-19 |
| <i>Pomoxis nigromaculatus</i> | black crappie | | | | Q5 - 1995-09-22 |
| <i>Notropis atherinoides</i> | black netherline | THR | 2007 | THR | Q5 - 1995-09-19 |
| <i>Notropis heterodon</i> | blackchin shiner | | | | Q5 - 1995-09-19 |
| <i>Notropis heteroclitus</i> | blacknose shiner | | | | Q5 - 2000-02-18 |
| <i>Percina maculata</i> | blacknose darter | | | | Q5 - 1995-09-24 |
| <i>Rundulus notatus</i> | blackstripe topminnow | SC | 2002 | 15L | Q5 - 1995-09-20 |
| <i>Leucostichus xanthurus</i> | bluegill | | | | Q5 - 1995-09-23 |
| <i>Ameiurus notatus</i> | bluntnose minnow | | | | Q5 - 1995-09-17 |
| <i>Amia carya</i> | bowfin | | | | Q5 - 1995-09-09 |
| <i>Hypogomphus heteroclitus</i> | brook minnow | | | | Q5 - 1995-09-19 |
| <i>Notropis notatus</i> | brocked madtom | | | 12AC | Q5 - 1995-09-19 |
| <i>Lepomis gibbosus</i> | brook silverside | | | | Q5 - 1995-09-20 |
| <i>Catfish maculatus</i> | brook stickleback | | | | Q5 - 1995-09-20 |
| <i>Ameiurus nebulosus</i> | brown bullhead | | | | Q5 - 1995-09-19 |
| <i>Notropis sp.</i> | buffalo | | | | |
| <i>Umbra lim.</i> | central mudminnow | | | | Q5 - 1995-09-13 |
| <i>Notropis punctatus</i> | chanded killifish | | | | Q5 - 1995-09-19 |
| <i>Cyprinus carpio</i> | common carp | | | | Q5 - 1995-09-13 |
| <i>Notropis cornutus</i> | common shiner | | | | Q5 - 1995-09-18 |
| <i>Pomoxis sp.</i> | crappie | | | | |
| <i>Semotilus atromaculatus</i> | crayfish | | | | Q5 - 1995-09-17 |
| <i>Percina sp.</i> | darter | | | | |
| <i>Ambloplites rupestris</i> | eastern sand darter | THR | 2002 | | Q5 - 1995-09-24 |
| <i>Notropis atherinoides</i> | emerald shiner | | | | Q5 - 1995-09-19 |
| <i>Semotilus notropis</i> | fathead | | | | Q5 - 1995-09-17 |
| <i>Etheostoma fasciata</i> | fathead darter | | | | Q5 - 1995-09-23 |
| <i>Pomoxis promelas</i> | fathead minnow | | | | Q5 - 1995-09-17 |
| <i>Aplodinotus grunniens</i> | freshwater drum | | | | Q5 - 1995-09-25 |
| <i>Notropis buchanani</i> | ghost shiner | | | | Q5 - 1995-09-16 |
| <i>Coreoperca cepedianum</i> | gizzard shad | | | | Q5 - 1995-09-22 |
| <i>Moxostoma valenciennianum</i> | golden perch | | | | Q5 - 1995-09-19 |
| <i>Notropis heteroclitus</i> | golden shiner | | | | Q5 - 1995-09-19 |

Done Local Internet

Figure 21. Stream query results for all fish species including SAR

Ontario Conservation Authorities has been developed for staff within Conservation Authorities (CA), Ontario Ministry of Natural Resources, Ontario Ministry of Transportation and other partner agencies to aid in determining whether development proposals should be referred to Fisheries and Oceans as a result of the potential presence of SAR and the impacts of the development proposal activities on the SAR and their habitat. This Atlas covers all Conservation Authorities with SAR samples that fall within each CA jurisdiction, and promotes the development of a comprehensive, thorough reference for species at risk. The goal of the document was not only to identify areas where species at risk have been found in the past, but also to synthesize data among partners and to incorporate data not found within the database.

In total, there are 143 maps in digital format (on an accompanying CD), as well as in hard-copy (Figure 25).



Figure 25. Aquatic species at risk distribution maps CD

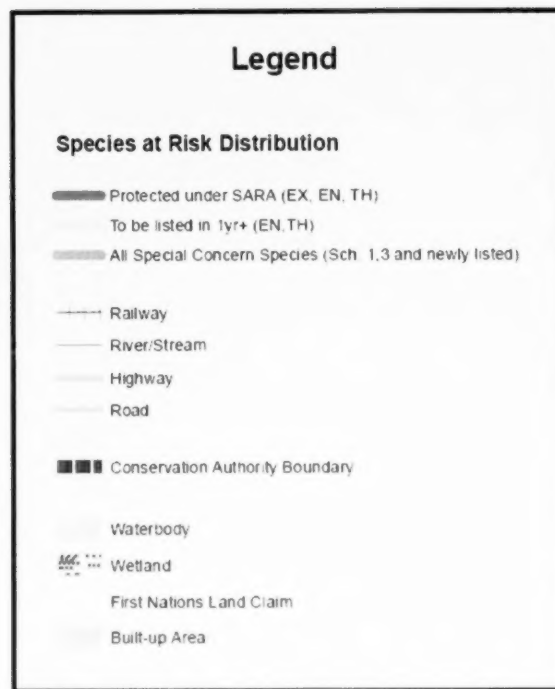


Figure 27. SAR distribution map legend

The representation of the SAR data in the web mapping application not only synthesizes the data sources located in-house with the products given to partners, but also facilitates the referral process by providing a common “look and feel” for biologists that deal with requests from those partners.

4.0 DISCUSSION

4.1 LIMITATIONS TO IDENTIFYING SPECIES AT RISK DISTRIBUTIONS

Inevitably there are several limiting factors that impede the study of Species at Risk, specifically on their distributions and critical habitat – factors such as lack of money, resources and knowledge. These factors may be compounded by climate change, where a species range may either diminish or migrate further north to compensate for higher water temperatures, precipitation, or even loss of habitat. Identifying known distributions of SAR is a great foundation for studying their potential distributions and understanding their habitat and spawning requirements. These known distributions can be used directly in scientific models to identify critical habitat and predict SAR distributions based on characteristics of existing data.

4.2 MODELING SPECIES AT RISK IN THE SYDENHAM RIVER WATERSHED

In addition to the SAR tools that have been developed, there have been attempts to model the distribution of SAR in Ontario based on habitat and landscape characteristics of existing SAR locations. One particular study looked at SAR distributions in the Sydenham River watershed, and examined the correlations between species and the landscape variables associated to segments within the ALIS stream layer (Casselman, 2004). Not only does the Sydenham River watershed (Figure 26) have high aquatic species richness, there is also a wealth of existing fish, SAR and habitat data that

has been collected by DFO, OMNR, and conservation authorities. There are also a number of species within the watershed that have been listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as species that are extirpated, threatened, endangered or special concern, both nationally and provincially (Schedule 1).

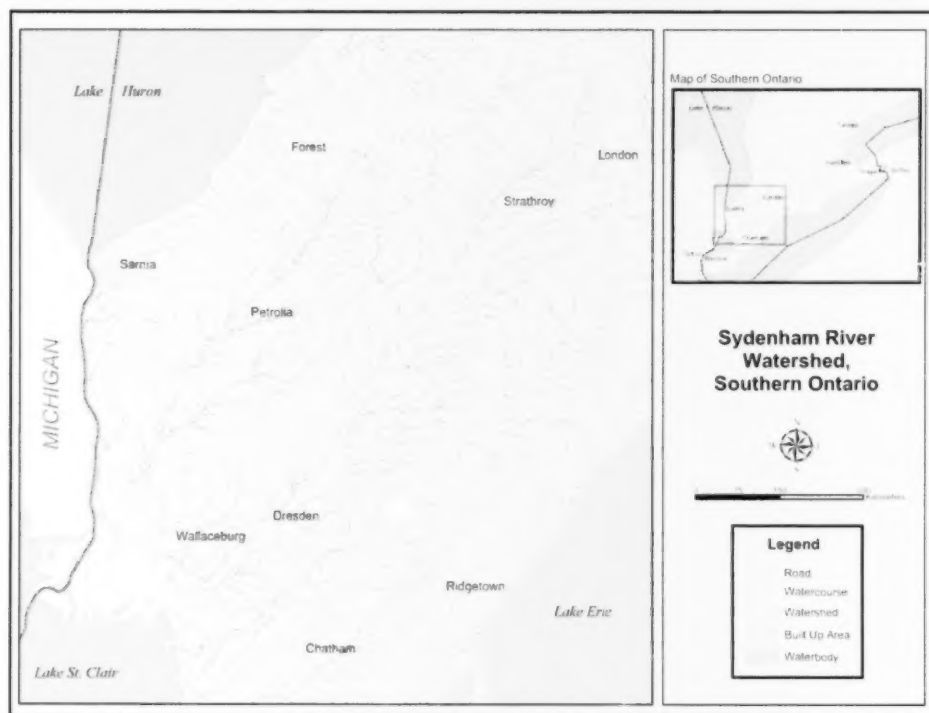


Figure 28. Sydenham River watershed, southern Ontario

This particular study provides several positive steps into predicting the distributions of fish species at risk, including desktop decision-making tools, targeted sampling sites and online planning and educational tools. Insight into fish-habitat relationships will help to provide desktop decision-making tools. Utilizing predictive models to define critical

habitat will not only offer potential species distributions, it will also provide a framework for identifying critical habitat associated to those species. Generating predictive models will also facilitate decisions on target sampling areas prior to field sampling. Field sampling is generally done throughout the spring/summer/fall seasons and done in locations where SAR are known to occur, or historically known to occur; however, new sites are also chosen in an effort to find new SAR locations and habitat. Predicting SAR distributions will assist in identifying new potential sites prior to venturing out into the field, which will inevitably save valuable time and money. These predictive models and scientific results can be provided to Fish Habitat Management biologists to aid in the decision-making process – viewed through an intranet web site. Using this tool, managers and biologists will be able to identify and clearly distinguish actual and predicted SAR locations, and incorporate this valuable information into the fish habitat management decision-making and referral process.

4.3 ADDITION OF NEW DATA

When DFO receives new data from partners, it is quite evident that the quality and accuracy has increased dramatically over the past decade. One could apply the methodology outlined in this document, however, a simple visual assessment of the data is often enough to confirm that the location of the point data is correct. With technological advances in GPS receivers and hand-held data collection units, accuracy of GPS sampling locations has increased significantly and is evident in programs that collect sample data on an annual basis. Not only are the coordinates more accurate, but users are

able to standardize the entry of field data using a variety of methods such as drop-down lists and auto-populating fields.

New technology, such as the Trimble TM GeoXT, used by DFO science in field data collection for SAR in Ontario, not only has a high-precision GPS receiver, but also utilizes a Windows TM CE platform. Using software such as ESRI's TM ArcPad[®] and ArcPad Application Developer[®], traditional paper field sheets can be created digitally, in a variety of formats including shapefiles, tables or delimited text files. Each digital format can be customized to meet user's needs through simple-to-use data entry fields filled out using a touch-screen pen. Limiting the user input, not only reduces the potential for transcription error, it also reduces time and resources traditionally associated with data entry in field work and quality control/assurance.

DFO science has been developing a Species at Risk data collection application to collect, monitor and facilitate the management of fish sample sites across Ontario. Using the TrimbleTM unit and a customized data collection application that runs in ArcPad[®], field crews can effectively and efficiently collect site specific field data (Figure 29) and species information (Figure 30) that is easily transferable into a GIS database. This data can then be used to update information on Species at Risk on the fish distribution web mapping application.



Figure 29. Digital field sheets of site information



Figure 30. Digital field sheets of species sampled information

5.0 CONCLUSION

Using and applying models, such as the one used in the Sydenham River study, requires careful consideration of three factors; accurate stream data, accurate fish sampling data (geographical locations and biological information) and habitat data. Without sufficient accuracy of these three factors, the predictive capability of the model may under or over-represent the distributions of SAR and their habitat. Under-representing SAR distributions and over-looking their potential habitat may result in the alteration, disruption or even destruction of their habitat, if current proposed projects proceed on stream segments that are classified incorrectly. Careful consideration of modelling procedures and accurate representation of stream and habitat characteristics is necessary.

As new fish and habitat data are collected, the predictive capability of these models will improve and increase their role in the protection and conservation of critical aquatic habitat required by fish and mussel species at risk. While the methodology outlined in the report may serve as a viable solution for locating or re-locating historical sample data, there is evidently an element of uncertainty with some of the data – especially in quantifying the accuracy of the results. This problem is compounded when finding the “correct” waterbody, as in this report, is replaced by finding the correct location on the “correct” waterbody. With the continuing support of GIS analysts, new technology, field crews, fisheries biologists and managers, viable solutions can be developed and implemented to support national and regional DFO programs, committed to the protection of fish habitat.

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